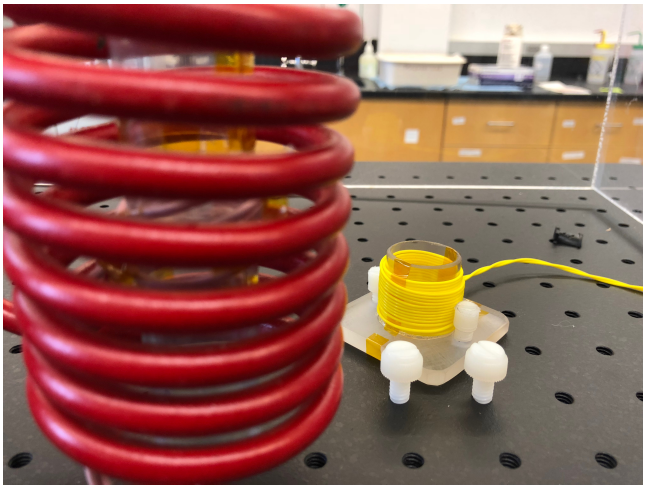
# Physics 152 - Accelerated Physics II: Electricity, Magnetism, and Optics

Lafayette College, Fall 2018



## Professor

Zoe Boekelheide

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Office hours: MW 2-4pm

## Class meeting times

Lecture/discussion: MWF 10-10:50am in HSC 142

Lab: Tuesday 1:10-4pm in HSC 142 (Room may be moved to HSC 119)

## About this course

This one-semester course will cover electricity and magnetism at the sophomore undergraduate level. The physics of electricity and magnetism seems to be explained extremely well by current theory (unlike some other fields of physics). Almost all electromagnetic phenomena can be described using Maxwell's equations plus the Lorentz force law.

Although the fundamental physics of electromagnetism is well-understood, that does not make it trivial or uninteresting! Electromagnetism is one of the most relevant fields of physics to our daily

lives. Almost all forces you encounter on a daily basis, besides gravity, are electromagnetic in nature. Friction and the normal force are some examples. Chemical bonds and biological processes are also electromagnetic in nature. The very powerful devices you use on a daily basis, such as smartphones, computers, and hard drives, rely on an understanding of electromagnetism inside materials. The study of electromagnetic properties of materials is a huge area of research in physics and related fields (including my own research on magnetic materials).

The course catalog says Physics 152 is: "An accelerated calculus-based introduction to the study of physics for science and engineering majors; a foundation on which an understanding of physics, physical chemistry, or engineering can be built. Topics include electrostatics, electric currents, magnetostatics, induction, electromagnetic waves, ray optics, interference and diffraction. A course satisfying degree requirements in all B.S. or A.B. degree programs. Not open to students with credit for Physics 133."

## Prerequisites

Calculus-based mechanics (Physics 131 or Physics 151 or equivalent) is a prerequisite for this course.

Math 263 should be taken concurrently if you have not taken it already.

## Communication with Prof. Boekelheide

In person: Office hours are set times when I make sure I am available in my office to meet with students on a drop-in basis. You may stop by any time during these hours and talk with me or ask a question. I expect to see every student in my office hours at some point during the semester! You can try stopping by my office at times outside my office hours, but I may not be available to meet with you. You can also e-mail me to set up another meeting time if my office hours don't work for you.

By e-mail: I check e-mail regularly. If you e-mail me, you should expect to hear back from me within 24 hours Mon-Fri (barring travel or other circumstances). Likewise, I will use e-mail to notify the class of reminders, weather cancellations, assignment clarifications, etc. You should check your e-mail every day, or if you suspect weather cancellations, to ensure you receive these communications.

## Course Website

We will use moodle, `http://moodle.lafayette.edu`. When I send email to the class, I typically use moodle, so make sure to check the e-mail address associated with moodle.

## Course materials

For this course, you will need the following textbook:

- **Textbook:** Sears and Zemanskys University Physics with Modern Physics, 14th ed., by Young and Freedman.
  You DO NOT need the MasteringPhysics access code. The textbook is available from the Lafayette bookstore. It also should be on reserve at Skillman Library.
- **Physics 152 lab manual:** Available at the bookstore.

## Learning Outcomes

After completing this course, you will be able to....

- Analyze the behavior of particles in response to electric and magnetic fields.
- Understand the connection between potentials, fields, and sources.
- Understand the interrelation of electric and magnetic fields through Maxwell's equations.
- Construct and analyze AC and DC circuits.
- Analyze optical systems with one or more lenses.
- Analyze the behavior of systems exhibiting interference.

In addition to the outcomes listed above, this course (particularly the lab component) will promote the following outcomes from the Natural Sciences section of the Common Course of Study:

- NS1. Understand that the goal of science is to comprehend phenomena in the physical and natural world.
- NS2. Employ the fundamental elements of the scientific method:
  - NS2a. Demonstrate the ability to recognize and/or formulate a testable hypothesis based upon observations or existing scientific data;
  - NS2b. Generate, collect, and analyze evidence relevant to testing a hypothesis;
  - NS2c. Evaluate whether the evidence supports or refutes the hypothesis or leads to the development of a new line of inquiry and/or a revision of the original hypothesis.
- NS3. Create, interpret, and critically evaluate descriptions and representations of scientific data including graphs, tables, and models.
- NS4. Understand scientific uncertainty and how it is reduced with additional data acquisition and hypothesis testing.
- NS5. Distinguish the difference between scientifically testable ideas and opinion.

## Grades

Grades on various assignments serve multiple purposes:

- To provide feedback on your performance on given assessments (e.g. exams, reports). Ideally, your performance on such assessments reflects your understanding of the material, i.e. the degree to which you have met learning outcomes.
- To provide more immediate incentives for certain behaviors which are beneficial to your learning (e.g. studying or completing homework) or to the class as a whole (e.g. participating in class).

Your final course grade will be determined as follows:

| | |
|---|---|
| Homework | 20% |
| Lab overall | 10% |
| Lab technical report | 10% |
| Participation | 5% |
| Exam #1 | 15% |
| Exam #2 | 15% |
| Final exam | 25% |

## Detailed description of course components

### Homeworks

Weekly homework assignments will be distributed in class and on Moodle. Homework will generally be due on Wednesdays at 11:59pm unless otherwise noted. Homeworks should be turned in to a bin in the hallway near my office door. Each problem will be equally weighted in your homework grade unless stated otherwise.

Doing the homeworks carefully and completely, checking your work, and redoing any problems that you missed, is the best way to learn the material and to study for the exams. And remember I said I expected to see you in my office hours? Make sure you give yourself enough time to ask questions about the homework before it's due.

### Labs

You will do 10 experiments over the course of the semester. Informal lab reports will be completed by pairs of lab partners during the lab period and submitted at the end of the period. You should purchase a Physics 152 lab manual at the bookstore. For this course, lab reports will be submitted on loose paper; you do not need a lab notebook. You must pass the lab component of the course in order to pass the course as a whole.

## Technical report

You will write a technical report about one of the lab experiments performed during the semester. Unlike the informal lab reports, the technical report is an individual project. The technical report should cover the experiment as described in the lab manual, and then go a little bit further. For example, you may choose to take additional data to clarify a conclusion, or perform additional data analysis beyond what is described in the lab manual.

Because your technical report will build upon a previous experiment, you should **SAVE YOUR DATA** for lab experiments during the semester. Save data in your network drive or by emailing it to yourself. Files saved on the lab computers are deleted when you log off.

The expected length of the technical report is about 5-15 pages (12 point font, double-spaced, including figures). Further information will be provided later in the semester.

Timeline for technical report submission:

| | |
|---|---|
| Decide on topic | November 16 |
| Draft due (submit 2 paper copies) | November 30 |
| Peer review due | December 3 |
| Final draft due | December 7 (last day of classes) |

Two lab meetings are reserved for you to work on technical reports. This would be the time to take additional data, if you let me know in advance what equipment you will need available. You may also use this time to discuss reports with other students or myself.

## Class participation

You are expected to attend class, arrive on time, and participate in class discussions and group problem solving or other activities.

## Exams

There will be two exams and a final:

- *Exam #1* will be on Friday, October 5, in class.
- *Exam #2* will be on Friday, November 9, in class. This exam will assume knowledge of material covered before Exam #1, but will primarily focus on material covered since then.
- The *Final Exam* will be a three hour exam during finals week at a time determined by the Registrar. The final exam is a cumulative exam, with slightly more emphasis placed on material covered since Exam #2.

Exam questions will resemble problems worked on homework and discussed in class. The exams will be closed book with an equation sheet provided.

## Intellectual honesty

You are expected to abide by the principles of intellectual honesty outlined in the Lafayette Student Handbook (available from http://studentlife.lafayette.edu).

Learning is a collaborative process. Discussion and collaboration on homework in this course is strongly encouraged. However, the work you turn in must be your own. You must understand and individually write out your answer to each problem. Acknowledge your collaborators on your homework paper.

Exams must be done on your own, using only materials specifically allowed.

An intellectual honesty statement specific to physics courses is posted on Moodle.

## Accommodation

If you have any disabilities which you feel may interfere with your ability to succeed in this class, please contact me to discuss ways of accommodating them.

*Mandatory statement for any Lafayette course with a disability policy.* In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the semester, except for unusual circumstances, so arrangements can be made. Students must register with the Office of the Dean of the College for disability verification and for determination of reasonable academic accommodations.

## Mandatory Moodle privacy statement

Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

## Mandatory credit hour statement

The student work in this course is in full compliance with the federal definition of a four credit hour course. **The federal course credit rule requires a total of 180 hours (12 hours/week) of student work over an approximately 15-week semester for a full unit (four credit hour) course.** See the Registrar's Office web site for the full policy and practice statement (http://registrar.lafayette.edu/additional-resources/cep-course-proposal/).

## Schedule for Lafayette Fall 2018 PHYS152 course
## Prof. Zoe Boekelheide

| Lec | Week | Date | Topic | HW due | Lab (Tues 1:10pm) |
|---|---|---|---|---|---|
| 1 | 1 | 27-Aug | Charges and electric force | | |
| 2 | | 29-Aug | Electric field; Superposition | | Introductory meeting |
| 3 | | 31-Aug | Electric field lines | HW 1 | |
| 4 | 2 | 3-Sep | Dipoles; Electric flux | | |
| 5 | | 5-Sep | Gauss's Law | HW 2 | Electric fields |
| 6 | | 7-Sep | Gauss's Law | | |
| 7 | 3 | 10-Sep | Conductors | | |
| 8 | | 12-Sep | Electric potential energy | HW 3 | Gauss's Law |
| 9 | | 14-Sep | Electric potential | | |
| 10 | 4 | 17-Sep | Gradient | | |
| 11 | | 19-Sep | Capacitance | HW 4 | Electric Potential mapping |
| 12 | | 21-Sep | Dielectrics | | |
| 13 | 5 | 24-Sep | Current; Power | | |
| 14 | | 26-Sep | Resistance | HW 5 | DC circuits; I-V curves |
| 15 | | 28-Sep | DC circuits | | |
| 16 | 6 | 1-Oct | RC circuits | | |
| 17 | | 3-Oct | Review electrostatics | HW 6 | Transients in RC circuits |
| 18 | | 5-Oct | **Exam 1** | | |
| | 7 | 8-Oct | **Fall break** | | |
| 19 | | 10-Oct | Introduction to magnetic fields | | No lab - fall break |
| 20 | | 12-Oct | Magnetic force on a moving particle | HW 7 | |
| 21 | 8 | 15-Oct | Sources of magnetic field (Biot-Savart) | | |
| 22 | | 17-Oct | Biot-Savart applications, continued/Ampere's Law | HW 8 | e/m lab |
| 23 | | 19-Oct | Ampere's Law | | |
| 24 | 9 | 22-Oct | Practice finding magnetic field | | |
| 25 | | 24-Oct | Gauss's Law for magnetism; Lenz's law, Faraday's | HW 9 | current balance |
| 26 | | 26-Oct | Faraday's law demos and practice | | |
| 27 | 10 | 29-Oct | Inductance | | |
| 28 | | 31-Oct | RL circuits | HW 10 | Faraday's law |
| 29 | | 2-Nov | RLC circuits | | |
| 30 | 11 | 5-Nov | Faraday's law cont. | | |
| 31 | | 7-Nov | Displacement current | HW 11 | Work on technical reports |
| 32 | | 9-Nov | **Exam 2** | | |
| 33 | 12 | 12-Nov | Maxwell's equations; EM waves | | |
| 34 | | 14-Nov | EM waves | HW 12 | RLC (AC) circuits |
| 35 | | 16-Nov | EM waves | | |
| 36 | 13 | 19-Nov | Diffraction and interference | | |
| | | 21-Nov | **Thanksgiving break** | | Work on technical reports |
| | | 23-Nov | **Thanksgiving break** | | |
| 37 | 14 | 26-Nov | Snell's Law, Refraction | | |
| 38 | | 28-Nov | Spherical mirror derivation | HW 13 | Interference and diffraction |
| 39 | | 30-Nov | Lenses | | |
| 40 | 15 | 3-Dec | Lenses | | |
| 41 | | 5-Dec | Evaluations, more lenses | | Tech report meetings |
| 42 | | 7-Dec | Review?? | HW 14 | Tech reports due |
| | | TBD | **Final exam (3 hrs, cumulative)** | | |